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Light-dependent chloride absorption in Vallisneria leaves

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temporary inactivity of the mechanism of photosynthetic phosphorylation, which then is prolonged *ad infinitum* after adaptation to cyanide.

Tentatively it is suggested that the chemical transformation (activation) of the enzyme system of photosynthetic phosphorylation might consist in an oxidation of a heavy-metal compound (cytochrome) because especially oxidised heavy-metal compounds react with cyanide. Alternatively an oxidation of an alcoholic group (e.g. in ascorbic acid) to a carbonyl compound might be suggested, the =CO-group also reacting reversibly with cyanide: JAMES (1953 I, 1953 II).

Light-induced chloride absorption shows, when the light is turned on, a comparable time lag as photosynthesis in *Vallisneria* (Chapter 3, Fig. 6). This suggests that a common process is limiting during the induction phase. If one or more stages of the chloride absorption process require energy-rich phosphates as the source of energy this common process is presumably photosynthetic phosphorylation. If, on the other hand, chloride absorption is brought about by one or more oxidation-reduction reactions exclusively, it might be supposed that the generation of the reduced or of the oxidised substances or both requires energy-rich phosphates. (It has been suggested that the reduction of pyridine nucleotide in chloroplasts requires the energy of ATP; STREHLER (1952). This is, however, not supported by recent results obtained by ARNON *et al.* (1957). It cannot, of course, be excluded that the induction lag in chloride absorption has nothing to do with the lag in photosynthesis.

The resulting picture of the chloride absorption process in *Vallisneria* leaves is the following: chloride ions and accompanying cations diffuse passively through the cell wall; subsequently the ions are bound to a carrier with the help of metabolic energy, presumably at the outer cytoplasmic boundary, in order to cross an outer layer which is impermeable to ions; perhaps the ions remain bound in the form of some kind of ion-carrier compound which is carried about from cell to cell in the symplasm; and finally at the tonoplasts the ions are somehow transferred into the vacuoles with or without the utilisation of metabolic energy. This picture possibly holds also for ion absorption in plant roots and other ion transport processes, but it is beyond the scope of this paper to extend the hypotheses thus far.

SUMMARY

The light-dependent chloride absorption in *Vallisneria* leaves was studied in its relation to the respiration-dependent chloride absorption, and to photosynthesis.

Light-dependent chloride absorption begins at full rate some five minutes after the light is turned on; it ends within two minutes after the light is turned off (Fig. 6). Light saturation is reached at a much lower light intensity than with photosynthesis (Fig. 7).

The action spectra of chloride absorption and photosynthesis are identical (Fig. 8), so chlorophyll is involved in light-dependent chloride absorption.

Carbon dioxide has no instantaneous influence on chloride absorption in the light, which proves the absence of a direct relationship between chloride absorption and carbon assimilation. Bicarbonate ions inhibit chloride absorption in the light

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as well as in the dark, but chloride ions do not inhibit photosynthetic bicarbonate assimilation.

Carbon monoxide inhibits the respiration-dependent chloride absorption only; it has no influence on light-dependent chloride absorption or photosynthesis (Chapter 6). The same probably holds for oxygen withdrawal (Chapter 7).

Cyanide inhibits chloride absorption instantaneously and fully reversibly. The inhibition of photosynthesis increases gradually when the leaf tissue is in the light until a stationary level is reached; in the dark the reaction with cyanide which causes the inhibition does not take place at all (Fig. 20). The inhibition is gradually reversible.

In Chapter 9 the photosynthetic assimilation of carbon dioxide and bicarbonate has been treated; a correction of an earlier paper on photosynthesis in Vallisneria has been included there.

The experimental data are discussed in Chapter 10.

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APPENDIX

DERIVATION OF THE VOLUMETER EQUATION

The volumeter is essentially a vessel partly filled with a watery solution in equilibrium with a gas phase which is kept at constant pressure and temperature. The water phase contains a certain amount of the gases in solution, in the case of air essentially nitrogen, oxygen and a little carbon dioxide. If, e.g. by photosynthesis, a small amount of oxygen is produced within the volumeter and a proportional amount of carbon dioxide is simultaneously removed, the vessel being shaken, a new equilibrium will be established. Part of the oxygen produced will pass into the gas phase and will therefore cause an increase in the oxygen partial pressure. Carbon dioxide is much more soluble than oxygen, therefore the carbon dioxide removed will for a relatively greater part be derived from dissolved carbon dioxide. Consequently the decrease in carbon dioxide in the gas phase and the concomitant decrease in its partial pressure will be smaller than the increase in oxygen in the gas phase and its partial pressure. As the total gas pressure is kept constant the increase in oxygen partial pressure (minus decrease in carbon dioxide partial pressure) will cause a decrease in the nitrogen partial pressure, and this in its turn will cause nitrogen to pass from the liquid to the gas phase. From this reasoning it will be clear that the gas exchanges occurring are quite complicated and that, especially when the liquid volume is large compared to the volume of the gas phase, the influence of changes in partial pressure